LETTERS TO THE EDITOR.

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Fresnel's Theory of Double Refraction.

THERE is a point in connection with the ordinary expositions of Fresnel's theory of double refraction to which, on account of its frequent occurrence, it is perhaps worth while to direct attention. It is found in Aldis's "Tract on Double Refraction," p. 7, in Preston's "Theory of Light," third edition, p. 328, and in Basset's "Treatise on Physical Optics," p. 115.

Having shown that when a molecule receives a displacement ρ, the other molecules of the system remaining fixed, the restoring force along the line of displacement is $F=\rho/r^2$, where r is the parallel radius-vector of a certain quadric, Preston, for instance, proceeds as follows:—"Hence, if we consider only the component F as effective, the equation of motion of the particle will be

$$d^2\rho/dt^2 = -\rho/r^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (10),$$

and the time of vibration will consequently be given by the equation

$$T = 2\pi r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11).$$

But the velocity of propagation is connected with the wave-length and the periodic time, by the equation $\lambda=vT$, therefore

$$v=\lambda/2\pi r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12).$$"

Now if equation (10) refer to the motion of a particle when the others remain fixed, there is no question of a wave at all, and the deduction of a propagational speed is without meaning; if, on the other hand, we are to regard (10) as giving the motion of a particle in the front of a luminous wave, then equation (11) expresses the bizarre result that the frequency, that is the colour, of the light is dependent upon the direction of vibration.

Fresnel's method was quite different; having determined the value of the restoring force on the supposition of absolute displacements, he employed it for the case of relative displacements, and regarding the component parallel to the wave as alone effective, he *assumed*, on the analogy of the transversal vibrations of a stretched string, that the propagational speed is proportional to the square root of the effective force. Hence, taking the azis of z in the direction of propagation, and making a suitable choice of the unit of mass, we should have in place of (10)

$$\partial^2\rho/\partial t^2 = 1/r^2 \; \partial^2\rho/\partial z^2,$$

giving in place of (12) $v=1/r$.

One other point may be mentioned. Preston and Basset, quoting from Verdet, state that one of the hypotheses on which Fresnel founded his theory is that the vibrations of polarised light are at right-angles to the plane of polarisation. This is not strictly correct. There is no doubt that this assumption played its part among the ideas that led Fresnel to formulate his theory: in the theory, however, as finally presented, it does not appear as a fundamental hypothesis; it follows, in fact, as a direct *consequence*. On the other hand, the postulate that the ether is incompressible should be included among the hypotheses of Fresnel; indeed, if this be not assumed, the effective component of the force of restitution would have, as Sir G. Stokes has pointed out ("Math. and Phys. Papers," iv., 158), a value quite different from that given by Fresnel. JAMES WALKER.

Oxford, January 19.

On an Alleged New Monkey from the Cameroons.

I MUCH regret that in describing, in NATURE for October 26 last, the monkey on which I bestowed the name *Cercopithecus crossi*, I overlooked the description of *C. preussi* by Matschie. Dr. Lönnberg, of Stockholm, was kind enough to write me early in November to say that he had "a strong suspicion that your guenon may prove identical with *C. preussi*," described in *Sitz. Ber. Naturforsch. Freunde Berlin* in 1898. Only last week, however, was I able to consult this volume, and there is no doubt that, as Mr. Pocock has now also pointed out, Matschie's name has priority over *C. crossi*. HENRY O. FORBES.

The Museums, Liverpool, January 27.

FORESTS AND RIVERS.

AT the recent meeting of the International Navigation Congress at Milan, one of the questions taken into consideration was "the influence which the destruction of forests and desiccation of marshes has upon the *régime* and discharge of rivers," and seven papers bearing on the subject were read and discussed. Of these, three were from Austria, and the others from Germany, France, and Russia. The problem as to the effect of forests on the water supply of rivers and on climate is of great social importance on account of the agricultural and commercial interests which are so closely connected with the use of timber, and with the utilisation of running water.

It is allowed by all the authors of these papers that, due to the improvident way in which the forests have been dealt with, there has been a marked change in the water supply of the neighbouring rivers; that where forests have been cut down brooks have disappeared, and many small rivers that at one time were useful as sources of power are so no longer for want of water; that in the larger rivers torrents have become more impetuous, and flooding more frequent; while, on the other hand, navigation suffers at times for want of water.

The greatest harm has been done in the mountain districts, where the steep slopes allow the rain-water to run off too rapidly, carrying away the surface soil and transporting pebbles and boulders into the rivers, causing shoals, and thus decreasing their capacity to discharge the flood water.

The extent to which forests, both on the Continent and in America, are being cut down and destroyed, and large areas of land, which at one time were covered with primæval forest, have become barren waste by fire or the lumberman's axe without any attempt at re-afforestation, was one of the subjects dealt with in the presidential address of Mr. J. C. Hawkshaw at the Institution of Civil Engineers in 1902. Mr. Hawkshaw pointed out that, notwithstanding the displacement of wood in building structures by iron, yet large quantities of timber are still required, not only for building purposes, but for temporary structures, such as coffer dams and scaffolding; pit props for mining; sleepers required for the railways, which, in this country, he estimated at an annual value of 18 million pounds, and those required for renewals at three-quarters of a million pounds; while for the railway service of the United States there are required 15 millions of acres of forest land to maintain a supply of sleepers.

The question for consideration at the Congress was whether the wholesale destruction of forest land for cultivation or for timber supply is having any material effect on the rainfall and consequent water supply; and the effect of forest destruction on the rivers of the country from which the trees are removed was also considered.

The physical conditions of forest land are that, owing to the shelter from sun and wind, the atmosphere is generally colder and damper than in the open country, and evaporation consequently less. It is calculated that a hectare of forest land (2½ acres) gives off every day 37 cubic metres of oxygen and 37 metres of carbonic acid, leading to a great expenditure of heat; and that from every hectare of forest land sufficient heat is abstracted to melt 316 cubic metres of ice. Ligneous plants also withdraw from the ground and discharge as vapour more than 40,000 gallons of water per hectare per day, which causes a sensible reduction of temperature. When clouds pass over a forest they encounter a cool, damp atmosphere, the point of saturation comes closer, and

rain is caused. This condition of forest land has been remarked on by aëronauts, who find that a balloon is invariably affected, and drops when passing over forests.

The advantages claimed for forests with regard to water supply are that the trees act as regulators of the rainfall; that the average quantity of rain falling on land covered with forests is greater than in the open ground to the extent of about one-sixth; that it holds up the water for a time and discharges it later on when water is most required in river basins, the rain being held back by the leaves of the trees and coming to the ground more gradually; the rain that falls on the surface is also taken up by the layer of dead leaves on the ground, which permits of a gradual percolation to the subsoil. Observations show that in summer the ground of the forest is damper than that of the adjacent cleared land, and snow remains for a much longer period in forest land before melting than in cleared land.

On the other hand, it has been contended by some of those who have made a study of sylviculture that forests do not increase the quantity of water flowing to the springs and rivers, but reduce it. The numerous striking facts quoted do not bear out this contention, which is mainly based on the fact that the substratum water stands at a lower level on forest land than in the adjacent cleared ground. This fact is generally admitted to be the case at one period of the year. As the result of many years' observations, it has been found that the maximum level of underground water is reached in May, that the water accumulates in the ground from August to January; and that the rivers are supplied by this reserve, and were it not for this accumulation many brooks and river feeders would cease to flow in summer.

Several very striking examples are given by the authors of the papers as to the deleterious effect of cutting down forests, especially in hilly districts. In the commune of La Bruguière, the forests on the slopes of the Black Mountain were cut down; the consequence of this removal of the trees was that a brook which ran at the foot, and the water from which was used for driving some fulling mills, became so dried up in summer as no longer to be of any use, while in winter the sudden floods caused very great damage in the valley. The forests were re-planted, and as the trees grew up the water coming to the brook was so regulated as to serve its former useful purpose in driving the mills, and the torrents in winter were moderated. Several other examples of a similar character are given.

In Switzerland, amongst other examples is quoted one that occurred in the canton of Berne, where, owing to the re-planting of the mountain-side with fir trees, the water again appeared at a spring which had ceased to flow. After a period the trees were cut down and the land converted into pasturage, since when the spring has almost disappeared, only opening out at occasional intervals.

In the Kazan district of Russia, once celebrated for its forests of oaks and linden, which are now nearly all cut down, there were formerly seventy water-mills constantly at work. Less than half now can be worked, and even they only run half time, and are idle in summer for want of water; while in winter the little rivers that worked these mills are converted into impetuous torrents, breaking up the mill dams and doing other damage. These abandoned water-mills stand out as a striking proof of the consequences of the destruction of forests.

In Sardinia, where the surface consists of plutonic rocks covered with a thin layer of earth, all the streams have a rapid slope. The woods, which occupied in 1870 an area of more than 2½ million acres, or about 43 per cent. of the whole surface of the island, now are reduced to about one-sixteenth of this area. Since the removal of the trees the floods in the rivers rise with a rapidity and flow with a velocity never known before, and a great number of bridges have been destroyed by the floods. The beds of the channels have been raised in some places above the surface of the land, owing to the detritus brought down in floods.

In Wisconsin, U.S.A., the settlers cut down the forests and converted the land into tillage and pasture. During a period of about seventy years nearly the whole of the forest land was thus cleared, with the result that, as the forest disappeared, the water in the river became lower; finally thirty miles of the channel entirely dried up, and many water-mills that were formerly worked by the stream are now deserted and useless, owing to the want of water to run them.

In Sicily, owing to the cutting down of the forests on a vast scale in the province of Messina, the bed of the river has been raised by the stones and earth carried down by the torrents so as to stop all drainage from the land, and great damage has been done by the floods. Several other examples are given to the same effect where forests have been cleared in the same district, and these are compared with other streams where the forests still exist and their condition remains unaltered. In the former case, landslides from the mountains have become very frequent.

VARIATION OF GLACIERS.[1]

THIS interesting report of the Commission internationale des Glaciers shows that these ice-streams still continue to diminish in those parts of the world which it has been possible to examine. In the Swiss Alps, of ninety glaciers observed, not one shows an advance, which fully confirms the general results of the last seven years, and indicates that any slight variation is now at an end; the same is true of the Italian Alps, though some of them give signs of increase in their upper parts. In the French Alps (Pelvoux district), the Glacier Noir has steadily decreased since 1860; the Glacier Blanc, after decreasing from 1865 to 1886, advanced from about 1889 to 1896, but is now again retiring. It is noteworthy that the average elevation of the supply basin of the former is from 2500 to 2800 metres, and of the latter from 3000 to 3300 metres. In the Savoy Alps the shrinkage continues, some small glaciers having disappeared. The same is true in the Pyrenees.

In Norway both snowfall and temperature were rather variable in 1904, but the glaciers, with a few exceptions, have retreated; and in Greenland the Jakobshavn Glacier has shrunk, sometimes rather considerably. In the Caucasus (central) the glaciers continue to retreat; less is known of the eastern district, but the same apparently is true of it. During the past year M. Fedtchenko visited more than 110 glaciers in the Pamir, and has stated that all appeared to be diminishing. The same is true, with a few exceptions, of the north-western part of the United States, as well as of the mountain region of western Canada. In Africa, though the rainfall had been unusually heavy in the Kilimanjaro district, the amount of snow in the crater of Kibo had not, according to

[1] "Les Variations périodiques des Glaciers." Dixième Rapport, 1904. Rédigé par H. F. Reid et E. Muret (Extrait des *Archives des Sciences physiques et naturelles*, t. xx., juillet et août.) Pp. 34. (Genève: Georg et Cie, 1905.)